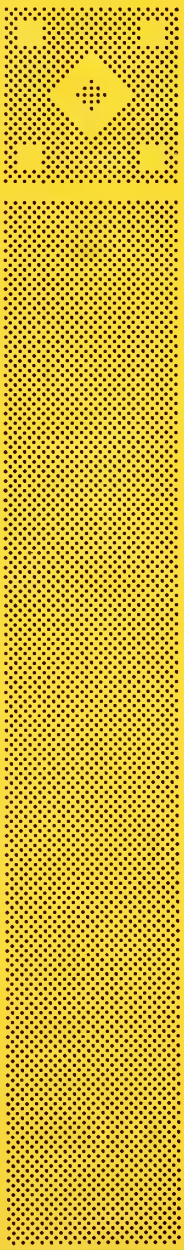
1965

WATERSHED WORK PLAN
for
WATERSHED PROTECTION
and
FLOOD PREVENTION



LAKIN WATERSHED
KEARNY COUNTY, KANSAS

KANSAS

JANUARY 1965

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WATERSHED WORK PLAN

LAKIN WATERSHED

Kearny County, Kansas

Prepared Under the Authority of the
Watershed Protection and Flood Prevention Act
(Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by

Kearny County Soil Conservation District
Lakin Watershed District No. 49

With Assistance by

U. S. Department of Agriculture
Soil Conservation Service

State of Kansas
State Soil Conservation Committee

January 1965

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SUMMARY OF PLAN

This plan for watershed protection and flood prevention is sponsored by the Lakin Watershed District No. 49 and the Kearny County Soil Conservation District. Technical assistance in preparing the watershed work plan was provided by the Soil Conservation Service, United States Department of Agriculture. The Soil Conservation Service negotiated a contract with George M. McKee, Jr., Consulting Engineers, Colby, Kansas, to collect and process engineering data. The State of Kansas, through the State Soil Conservation Committee, provided funds for these services.

Lakin Watershed, with a drainage area of 16.9 square miles or 10,806 acres, is located on the north side of the Arkansas River at Lakin, Kansas. A small portion of the upper drainage area is noncontributing except during major flood producing storms. The drainage system is made up of four independent drains which are intercepted by the Amazon Ditch irrigation canal. This irrigation canal receives all surface runoff from these drains up to the capacity of the ditch. Flood flows jump the canal and travel across the lower flood plain to enter the Arkansas River.

Floodwater damage to irrigated crops, leveled land, other agricultural property, and the city of Lakin are the principal watershed problems. Average annual flood damages in the watershed under existing conditions are estimated to be $50,300. The average annual damage after project installation, including land treatment and structural measures, is estimated to be $1,000. The difference of $49,300 represents an overall average annual reduction in flood damages of 98 percent.

Works of improvement will include needed land treatment measures together with structural works consisting of four floodwater retarding structures, two grade stabilization structures, and 12,639 feet of floodways. The floodwater retarding structures will have a total capacity of 2,907 acre feet including 303 acre feet of sediment storage and 2,604 acre feet of detention storage. They will regulate runoff from 12.20 square miles or 75 percent of the watershed area. The two grade stabilization structures will provide a stable grade where floodwater retarding structure release flows enter the Amazon Irrigation Ditch. The planned floodways carry outflows from the four floodwater retarding structures to the Amazon Ditch and provide a diversion of flood flows around the west side of the city of Lakin.

A period of three years is proposed for installing works of improvement at an estimated total cost of $689,600. $567,900 will be Public Law 566 funds and $121,700 will be from other sources.

Total average annual benefits of the project are $53,300. Damage reduction by works of improvement will result in benefits of $46,900 within the watershed. Benefits accruing from changed land use and from more intensive use are recognized but not evaluated. Secondary benefits of $4,000 will be realized from the project. Incidental recreation benefits will be realized from the project but were not tabulated in this plan.

The ratio of the total average annual benefits from structural measures, $53,300, to the average annual costs, $22,300, is 2.39 to 1.0.

Lakin Watershed District No. 49 will provide land easements and right-of-way and will contract for construction of the structural measures. The Watershed District Act requires the method of financing be adopted concurrently with the adoption of the general plan.

Land treatment measures will be maintained by landowners and operators of the farms on which measures have been installed. This will be accomplished by agreement with the Kearny County Soil Conservation District.

Structural measures will be operated and maintained by the Lakin Watershed District No. 49 at an estimated average annual cost of $3,000.

DESCRIPTION OF THE WATERSHED

Physical Data

Lakin Watershed lies in the Central High Plains of the Great Plains physiographic province. The Watershed District includes 10,806 acres in Kearny County. The area is about 8 miles long and 2 to 3 miles wide. Elevations range from 3,250 feet in the uplands of the watershed down to 2,980 feet at the lower end.

The watershed is divided into three topographic parts. The upper or northern part of the watershed is an upland plain sloping gently eastward with poorly defined pothole drainage. The lower or southern part is an alluvial fan protruding onto the north side of the Arkansas River flood plain. The river forms the southern boundary of the watershed. A broken area of steeply sloping land separates the bottom lands from the uplands. This transitional area, roughly two miles wide, runs in a northeast direction. Long, narrow drainageways forming at the edge of the upland plain have cut deeply across the land. Drainageways spread out and disappear on the flood plain.

Loess deposits of silts and clays blanket the upland plain and most of the slopes. Under the loess are Pleistocene deposits of very deep silt, sand, and clay. Intermixed sand, silt, and clay make up the alluvium in the Arkansas valley.

The Bridgeport clay loam soil is dominant on the alluvial fans and flood plain. This friable, well-drained productive soil comprises the major part of the irrigated land.

Colby and Ulysses friable soils occupy the sloping land. Colby soil is more extensive than the Ulysses soil. Colby soil occurs on steep to moderately steep slopes while Ulysses soil occurs on the more gentle slopes.

Richfield silt loam soil makes up the major part of the upland plain. This soil is the most important soil for agriculture in this area.

Land use in the watershed includes approximately 70 percent cropland, 23 percent pastureland, 4 percent urban, and 3 percent miscellaneous. Native vegetation consists of short grasses and is generally in fair to good condition.

Existing fish and wildlife resources of the watershed consist mainly of a sparse pheasant and jackrabbit population which provide limited hunting opportunities within the watershed. Lake McKinney with a surface area of 2,000 acres is located just east of the watershed boundary. This lake along with the Arkansas River and their adjacent areas provide recreational opportunities to the people of the watershed.

Average annual precipitation at Lakin, Kansas, is 16.48 inches. Annual precipitation amounts have varied from 7.53 inches in 1956 to 28.13 inches in 1946. Normally, about 76 percent of the precipitation falls during the growing season, April to October. The most intense flood-producing storms occur during the summer months. The highest temperature recorded at Lakin is 112 degrees and the lowest temperature recorded is 23 degrees below zero. The average date of the last killing frost is April 27 and the first killing frost is October 15. The average length of growing season is 171 days.

Economic Data

The watershed is made up of land with economic uses based on its location and topography. The upper portion of the watershed is quite level land which has no clearly defined drainage pattern. This land is used primarily for crop production. The upper portion breaks into gently rolling land which is used primarily for dryland farming. This breaks off rather abruptly into rolling land used for permanent pasture. Below these breaks is an area of gently, uniformly, sloping land which extends to the Arkansas River. Farmland on this slope is used primarily for irrigated crop production. It is on this slope that the city of Lakin, U. S. Highway 50, the Atchison Topeka and Santa Fe Railroad, and the Amazon Irrigation Ditch are located. State Highway 25 crosses this area north to south.

There are twenty farming units in the watershed. Farm units vary in size dependent upon the type of farming and location in relation to Lakin.

Land use in the watershed is as follows:

Land Use	Watershed Total	Flood Plain
Cropland	7,516	1,671
Pasture	2,500	50
Urban	480	480
Miscellaneous	310	50
Total	10,806	2,251

Irrigated cropland is used to raise alfalfa, sugar beets, grain sorghum, wheat, and forage sorghum. Dryland cropland is utilized by planting about one third to wheat, one third to grain sorghums, and leaving about one third in fallow.

The gross annual value of production from the area subject to flood damage is estimated at $104 per acre. The market value of this land is estimated to be around $350 per acre.

Lakin, a town of 1,455 population, is the county seat of Kearny County. It is a modern and prosperous town with paved streets and a water and sewage system. Homes appear to be kept in very good repair. Many new houses have been built in the past few years with new house construction continuing at a rapid rate.

The principal industry of the area is agriculture and its associated business. Natural gas production is an important economic factor with many wells located in the watershed.

WATERSHED PROBLEMS

Floodwater Damage

Damage resulting from flooding of highly developed agricultural lands and the city of Lakin is the principal problem. The larger floods recorded at Lakin occurred in 1894, 1902, 1905, 1908, 1914, 1915, 1924, 1927, 1933, 1949, 1951, and 1957. These floods were generally produced by high intensity storms of short duration.

Irrigated cropland, subject to flooding, amounts to 1,782 acres, 439 of which are below the watershed boundary. There are 328 acres of dryland cropland in the project area that are subject to flooding. Crop damage due to flooding averages $13,400 annually and accounts for 27 percent of the total flood damage.

Another major agricultural damage is caused by the movement of floodwater over land leveled for irrigation. Extensive re-leveling operations are necessary after each flood. Grain storage facilities have also suffered extensive damage. The Amazon Irrigation Ditch managers have recorded sizeable damages as a result of floodwater exceeding ditch capacity. These other agricultural damages total $6,300 average annually.

Road and bridge damage amounts to $300 on an average annual basis. Railroad damage figures were not available but would be insignificant as compared to other types of damage.

The Amazon Ditch and an earlier ditch no longer in existence have intercepted runoff from small frequent storms. Large amounts of runoff have overloaded the ditch capacity and sent floodwaters racing into the city causing extensive damage. Runoff from fields west of Lakin below the Amazon Ditch have also caused some flooding. Estimates of damage for most recent floods are $71,200 in 1949, $166,900 in 1951, and $73,400 in 1957. New home construction and commercial development have increased the damageable value of the urban area since these floods occurred. The total property value subject to flooding is approximately $5,174,000. Average annual urban flood damage is $19,800 or 39 percent of the total flood damage.

Floods cause considerable inconvenience to farmers and city residents alike. Interruption of transportation and utilities along with loss of business are not small items. Such indirect losses under present conditions are estimated to average $4,700 annually.

Sediment Damage

Damage from sediment deposition on irrigated flood plain land is a serious problem. Sediments, mainly silts and sands, have a detrimental effect on yields on 28 percent of the flood plain area. Some localized gravel deposits also cause damage. This type of damage totals $4,200 on an average annual basis.

Erosion Damage

Flood flows cause erosion on the flood plain. Large areas of the flood plain are damaged by sheet scour. Damage is caused on smaller areas by the cutting of scour channels. Flooding has caused scour damage on about 15 percent of the flood plain. This has reduced the productive capacity of some of the damaged areas by as much as 50 percent. Average annual erosion damage to the flood plain under present conditions amounts to $1,600.

Sheet erosion of sloping cropland has been a serious problem. This problem is effectively controlled through a system of land treatment measures. This problem will continue to be controlled as long as these measures are properly operated and maintained.

Problems Relating to Water Management

Irrigation within the watershed is practically all from wells. The Amazon Ditch conveys water from the Arkansas River to Lake McKinney for storage and to areas down river for irrigation. The Amazon Ditch intercepts the upland drainage of the watershed above the ditch. The ditch cannot handle the water at high flood flow. An attempt has been made to divert flow from two of the four major drains to a more desirable overflow location but this has been only partially successful. Any interruption of service of the Amazon Ditch can mean loss of production on irrigated areas outside of the watershed. Other creeks outside of the watershed can also cause interruption of canal use. For this reason benefits to the area served by the Amazon Ditch were not evaluated.

There is no interest in development of water storage for other agricultural or non-agricultural uses.

PROJECTS OF OTHER AGENCIES

The Kansas Highway Department plans to construct a section of four-lane highway through the north edge of Lakin on the present US 50 route. Ditches to provide lateral drainage for this curb and guttered highway will be required. These ditches will also provide outlet for low ponding areas along the north edge of town. Participating agencies in this project are the State Highway Department, Lakin Watershed District, city of Lakin, and Kearny County.

BASIS FOR PROJECT FORMULATION

The desire of the local sponsoring organizations is to reduce to the greatest degree economically possible, floodwater damage to the land, crops, city of Lakin, and other valuable properties within the flood plain. Officials of the city of Lakin, Kearny County, and State Highway Commission have cooperated fully with the watershed district toward attaining this goal.

Topography of the watershed provides four good sites for dam construction. Storage of water at these sites does not materially effect roads, pipelines, utilities, farm buildings, etc. Floodwater retarding structures at these four sites provide a practical and economical solution for the control of upland runoff.

Land leveling for irrigation has erased all natural drainageways across the flood plain. This factor makes extensive channel improvement unsuitable as a project measure in lieu of floodwater retarding structural control.

The Kearny County Highway Department's plan to construct a new road on the section line west of Lakin offered a solution to a flood problem caused by storm runoff from fields immediately west of town.

A floodway constructed in connection with the road will conveniently carry this runoff into Sand Creek.

WORKS OF IMPROVEMENT TO BE INSTALLED

Works of improvement to be installed consist of the necessary land treatment measures for watershed protection plus four floodwater retarding structures, two grade stabilization structures and 12,639 feet of floodway (See table 1).

Land Treatment Measures

The application of land treatment measures is essential to a sound and continuing watershed protection and flood prevention program. This is accomplished by the establishment and maintenance of all soil, water, and plant management practices essential for each land use. The result will be a reduction in runoff rates, erosion damages and sediment yield.

Most of the land treatment needed on the upland areas of the watershed has been applied. These are shown on table 1A. Amounts and cost estimates of the land treatment to be applied during project period are shown in table 1. The estimated total cost of planning and installing these land treatment measures is $99,200. Public Law 566 funds will not be needed to establish these practices.

Structural Measures

A system of four floodwater retarding structures, two grade stabilization structures and four floodways will be installed at the locations shown on the project map. Features of a typical floodwater retarding structure with principal spillways having single stage inlets are shown on Figure 1, page 32. Physical data for structures is presented in table 3.

The system will provide 2,604 acre feet of floodwater detention storage, 303 acre feet of sediment storage for a total of 2,907 acre feet. The system will control the runoff from a drainage area of 12.20 square miles. This is 75 percent of the watershed area.

Floodwater retarding structures have been planned with a floodwater storage of 4.00 inches of runoff from their drainage areas. This amount of storage would contain the maximum storm of record. Storage will be provided for the expected 100-year accumulation of sediment with a storage volume equivalent ranging from 0.35 to 1.00 inches from the drainage area above detention structures. Water will be stored in the sediment pools not to exceed the 50-year sediment accumulation level.

Floodwater retarding structures will be earth dams having single stage inlet principal spillways. The principal spillways will be reinforced concrete or a comparable quality material. They will have

an uncontrolled release rate of 10 c.s.m. Vegetated emergency spillways will be provided to release runoff exceeding reservoir storage capacity safely past the embankment. These spillways have been planned so that their chance of operation is less than one percent.

Floodwater retarding structures 1, 2, and 3 are planned with floodways to convey their principal spillway outflow into existing improved channels. Floodway no. 4 is to be built on county road right of way along the section line between sections 27 and 28 at the west edge of Lakin. This floodway is 4,049 feet long with 8' bottom and 3:1 side slopes, and includes an outlet to be constructed into Sand Creek comprised of 485 feet of 60" pipe with appurtenances.

Grade stabilization structures No. 1A and 2A are planned as concrete drop structures. They will provide a stable grade where release from the floodwater retarding structures enters the Amazon Ditch. Number 1A is planned in section 15 where the principal spillway outflow of dams 1, 2, and 3 will enter the ditch. This drop structure has a 28 foot weir and a drop of 8 feet. Design capacity is 694 c.f.s. Number 2A has a 14 foot weir, 6 feet of drop, and a capacity of 322 c.f.s. It will be located where the draw below dam number 4 enters the Amazon Ditch.

The floodwater retarding structures, grade stabilization structures, and floodways, will be installed at an estimated total cost of $590,400. The estimated cost of individual structural measures is shown in table 2.

EXPLANATION OF INSTALLATION COSTS

Public Law 566 costs for structural measures for flood prevention include construction cost and installation services cost. Construction cost includes general construction and vegetative establishment work of the character normally performed by contractors. Installation services include engineering, administrative service and overhead costs of programming and supervision.

Engineering services include all direct and related costs of the services of engineers and geologists for surveys, geologic site investigations and soil mechanics, structure design, construction plans and specifications, construction engineering and supervision. Administrative services include assistance rendered to the local contracting organization in preparing invitations to bid and in awarding construction contracts. Overhead costs include administration and program supervision at all levels concerned with the installation of the program.

Engineering service costs were computed as a percent of construction cost where functions are proportional to construction cost. Flat rates were used in computing functions with relatively fixed costs. Administrative services costs were computed at 8 percent of construction cost.

Construction cost estimates in this plan are based on computation of quantities derived from survey data at each site using unit costs for similar work on watershed projects currently under construction with a contingency allowance of 12 percent. At the time of project installation, additional surveys will be needed at the dam sites as a basis for structural design and construction cost estimates. Geologic drilling and soil mechanic tests and analysis will be performed to verify site and foundation conditions. Reservoir storage volumes will be computed from topographic maps made during work plan preparation.

Land, easements, and rights-of-way values were determined by the Board of Directors of the Lakin Watershed District. Cost estimates were based on current land values which are $60 per acre for the land involved. It is recognized that such values may not coincide with actual out-of-pocket costs to the local sponsoring organization because some easements and rights-of-way may be obtained by donation.

Contract administration costs of the local contracting organization will include cost of mailing bid invitations, salary, if any, and expenses of the contracting officer in administering construction contracts. Contract administration costs were estimated on the basis of experience of other watershed districts in Kansas which have carried out construction work.

The estimated total P.L. 566 structural cost and other obligations by fiscal years during the project installation period are as follows:

Fiscal Year	P.L. 566 Costs	Other Costs	Total
First	50,000	43,000	93,000
Second	443,000	44,100	487,100
Third	74,900	34,600	109,500
Total	567,900	121,700	689,600

EFFECTS OF WORKS OF IMPROVEMENT

Works of improvement provide flood protection from all storms up to and including the maximum storm recorded in the watershed. This storm exceeds slightly the magnitude of the 100-year frequency storm. Floodwater retarding structures provide the control of upland runoff necessary to make this protection possible. Storm runoff from the area below the structures will be intercepted by the Amazon Ditch and safely carried off to be added to the water stored for irrigation in Lake McKinney. The Amazon Ditch has an automatic flood by-pass at the west boundary of the watershed so flows exceeding ditch capacity will be discharged into Sand Creek. Runoff from the west below the Amazon Ditch will be routed around Lakin into Sand Creek by floodway No. 4. The drainage ditch and highway improvements in the north part of Lakin

will intercept storm runoff from a small area lying just to the north. Other contributing areas above Lakin and below the Amazon Ditch will drain into the natural depression in sections 21 and 22. With the works of improvement in place the depression area will not overflow. The sandy bottom of the depression area allows it to empty.

The flood prevention program will directly benefit eleven owners of agricultural land within the watershed. Works of improvement will protect 1,343 irrigated acres and 328 dryland acres of cropland within the watershed. 439 acres of irrigated cropland outside the watershed boundary will be directly benefited. Crop losses, scour and sediment damage, and re-leveling of irrigated land after scour damage caused by flood flows will be reduced to less than a 1 percent chance of occurrence.

Flood damage to that portion of the Amazon Ditch within the watershed will be virtually eliminated as 88 percent of the watershed area above the ditch will be controlled by structures.

Outside storm runoff will not be allowed to enter Lakin with the planned protective measures installed. The surface storm runoff removal system will be adequate to remove storm runoff from within the city. A very high level of flood protection to the city's 1,455 residents and their properties will be assured.

Benefits will be realized by county and state highway departments and the Atchison Topeka and Santa Fe Railroad.

Secondary benefits stemming from the project are realized from transporting, processing and marketing agricultural commodities produced as a result of reducing crop losses by flooding. Secondary benefits induced by the project include the increased net return to suppliers of farm equipment and materials required to achieve the increased agricultural production made possible by the project, the increased net return to local retailers and wholesalers from consumer expenditures by the farm family resulting from increased farm income, and any other increase in net returns resulting from costs directly associated with marketing or using project goods or services. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Recreational benefits in Lakin Watershed will accrue to the general public. Flood retarding reservoirs with sediment pools ranging in size from 5 to 18 acres will afford limited recreational facilities. A general benefit to the fish and wildlife resources of the area is expected.

PROJECT BENEFITS

Benefits of $53,300 accrue to flood prevention. All of these benefits are attributable to structural measures. Individual items of benefit are shown in tables 5 and 6.

Benefits from reduction in floodwater damage to crops average $10,400 annually and account for 21 percent of the primary flood prevention benefits within the watershed.

Benefits from reducing damages to flood plain land by scour and sediment will average $5,500 annually, accounting for 11 percent of the total flood prevention benefits within the watershed. Benefits from reduction in floodwater damage to roads and bridges amount to $300 and similar benefits to other agricultural property such as stored feed, fences, buildings, grain storage facilities, and other farm improvements are $6,300 on an average annual basis.

Indirect average annual benefits amount to $4,600 within the watershed.

Benefits from reduction in floodwater damages to homes and businesses in the city of Lakin average $19,800 annually and account for 37 percent of the total benefits.

The value of local secondary benefits stemming from the project is $3,700 with the value of secondary benefits induced by the project worth $300 giving a total value of $4,000 annually.

Flood prevention benefits outside the watershed accrue from works of improvement in the amount of $2,400 average annually. These benefits are from reduction in floodwater damage to irrigated crops.

In addition to the monetary benefits, there are other substantial intangible values which will accrue from the project, such as better living conditions, a sense of economic security and abatement of the fear of flood damage.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including installation, operation, maintenance, and replacement is $22,300. When the project is completely installed, the structural measures are expected to produce average annual benefits of $53,300. Therefore, the project will produce benefits of $2.39 for each dollar of equivalent cost (see table 6). The benefit cost ratio based on primary benefits is 2.21 to 1.

PROJECT INSTALLATION

The works of improvement will be installed in a three-year period. Federal assistance for carrying out the works of improvement on non-Federal land as described in this work plan will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

Land Treatment Measures

Land treatment measures will be established on the land by the farm owners and operators in cooperation with the Kearny County Soil Conservation District. The cost of applying these measures will be borne by the owners and operators of the land. The Soil Conservation Service will provide technical assistance in planning and establishing land treatment measures.

The Extension Service will assist in carrying out the educational phase of the program by preparation of general information in cooperation with the governing bodies of the Soil Conservation and Watershed District Boards. The Farmer's Home Administration soil and water loan program will be available to eligible farmers in the area. The County Agricultural Stabilization and Conservation Committees will cooperate with the governing bodies of the soil conservation districts to accelerate Agricultural Conservation Program financial assistance for those practices which will accomplish the conservation objectives. The supervisors of the Kearny County Soil Conservation District will encourage landowners and operators within the Lakin Watershed to install soil and water conservation measures on their farms.

Structural Measures

The Lakin Watershed District will contract for construction of the four floodwater retarding structures, two grade stabilization structures, and the 12,639 feet of floodway. All structural measures will be installed through construction contracts awarded on the basis of competitive bidding. Separate contracts will be awarded for general construction and for vegetative establishment. The local sponsoring organization will appoint a contracting officer and will bear the cost of contract administration.

The watershed district will obtain all land rights, easements, and rights-of-way needed for installation of the structural measures. The watershed district has power of eminent domain to obtain land rights for public improvements and has agreed to use such authority when needed. The watershed district will arrange for any relocation or modification of pipelines, communication lines, or other public utilities which are necessary in connection with the project installation.

After Federal assistance is authorized for installation of the project, the Soil Conservation Service will furnish engineering services to prepare construction plans and specifications for structural measures for flood prevention. Construction can then be started when all necessary land easements and rights-of-way have been obtained, P.L. 566 funds are available, and local sponsoring organizations have complied with State laws relating to approval of construction plans.

FINANCING PROJECT INSTALLATION

The Lakin Watershed District was created in accordance with the Kansas Watershed District Act as amended. The watershed district has all the necessary authority and power to finance and to carry out watershed improvements. These powers include the right to accept contributions, levy taxes, make assessments against land specially benefited, issue bonds, and exercise the right of eminent domain.

Expenses of $1,400 for organizing the district have been paid and current general expenses are being met by an annual ad valorem tax levy.

The watershed district has been furnished maps for all structural measures as a basis for contacting landowners and appraising costs to the district. Land rights will be financed by a general tax levy.

Funds for construction costs will be provided to the local sponsoring organizations as grants-in-aid through project agreements for construction executed with the Soil Conservation Service. A project agreement will be executed for each structural measure or group of structural measures to be included in a construction contract.

Federal technical assistance, installation services, and grants-in-aid for construction are contingent upon appropriation of funds for these purposes.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land treatment measures will be maintained by the landowners and operators of the farms on which the measures are installed under agreements with the soil conservation district serving the area. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and will encourage landowners to perform needed maintenance.

Structural Measures

An agreement providing for operation and maintenance of the structural measures will be executed by the local sponsoring organizations before Federal construction funds are made available.

Floodwater retarding structures, grade stabilization structures, and floodways will be operated and maintained by the Lakin Watershed District. All structural measures will be inspected by representatives of the Watershed District and the Soil Conservation Service at least annually and after each heavy runoff producing storm. Items of inspection will include but not be limited to the condition of the principal spillway and its appurtenances, emergency spillway, earth fill, the vegetative cover of the earth fill and emergency spillway, and any fences installed as a part of the structural measures. The Lakin Watershed District will maintain a record of maintenance inspections.

Maintenance work will be carried out when needed. Kinds of maintenance work that would be expected rather frequently are repairs to fence, clearing of debris and mowing of dams, spillways, and floodway, etc. Repairs to major construction items such as the dam and spillway are expected very infrequently.

The estimated average annual operation, maintenance, and replacement cost is $3,000. The necessary maintenance will be accomplished through contributed labor and equipment and/or hired labor and equipment. Funds for accomplishing the maintenance work will be obtained from an annual tax levy within the district.

Provisions will be made for free access of District, State, and Federal representatives to inspect the structural system at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Lakin Watershed, Kansas

Installation Cost Item	Unit	Number Non-Fed. Land	Estimated Cost (Dollars) 1/ P.L. 566	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Terrace Level	Ft.	37,000		1,300	1,300
Irrigation Land Leveling	Ac.	620		37,000	37,000
Well	No.	5		60,000	60,000
Technical Assistance				900	900
TOTAL LAND TREATMENT				99,200	99,200
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	4	391,700		391,700
Grade Stabilization Structures	No.	2	16,000		16,000
Floodways	Ft.	12,639	33,500		33,500
Subtotal Construction			441,200		441,200
Installation Services					
Engineering Services			91,400		91,400
Other			35,300		35,300
Subtotal Installation Services			126,700		126,700
Other Costs					
Land, Easements & R/W				19,500	19,500
Adm. of Contracts				3,000	3,000
Subtotal Other				22,500	22,500
TOTAL STRUCTURAL MEASURES			567,900	22,500	590,400
TOTAL PROJECT			567,900	121,700	689,600

1/ Price base 1964

January 1965

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Lakin Watershed, Kansas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Ac.	7,330	7,500
Range Proper Use	Ac.	2,660	1,300
Range Seeding	Ac.	430	3,900
Grassed Waterway	Ac.	3	400
Diversion	Ft.	5,280	400
Grade Stabilization Structure	No.	1	400
Farm Pond	No.	9	13,000
Terrace, Level	Ft.	491,000	19,500
Stubble Mulching	Ac.	4,580	9,200
Irrigation Land Leveling	Ac.	900	54,000
Well	No.	9	108,000
Total			217,600

1/ Price base 1964

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Lakin Watershed, Kansas

(Dollars)[1/]

Structure Site No.	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds			Total Installation Cost
	Construction	Installation Services Engineering	Installation Services Other	Total P.L. 566	Adm. of Contracts	Easements & R/W	Total Other	
Floodwater Retarding Structures								
1	62,000	15,700	5,000	82,700	300	1,800	2,100	84,800
2	119,000	19,700	9,500	148,200	300	4,900	5,200	153,400
3	75,000	16,700	6,000	97,700	300	2,600	2,900	100,600
4	135,700	20,500	10,900	167,100	300	5,000[2/]	5,300	172,400
Subtotal FRS	391,700	72,600	31,400	495,700	1,200	14,300	15,500	511,200
Grade Stabilization Structures								
1A	9,500	2,300	700	12,500	300	100	400	12,900
2A	6,500	4,000	500	11,000	300	100	400	11,400
Subtotal GSS	16,000	6,300	1,200	23,500	600	200	800	24,300
Floodways								
1	1,500	900	200	2,600	300	200	500	3,100
2	2,800	1,500	200	4,500	300	300	600	5,100
3	2,700	1,500	200	4,400	300	200	500	4,900
4	26,500	8,600	2,100	37,200	300	4,300[3/]	4,600	41,800
Subtotal Floodways	33,500	12,500	2,700	48,700	1,200	5,000	6,200	54,900
TOTAL	441,200	91,400	35,300	567,900	3,000	19,500	22,500	590,400

1/ Price base 1964
2/ Includes $1,525 for pipeline relocation
3/ Includes $2,500 for bridge over floodway

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TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Lakin Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 1	2	3
Drainage Area	Sq. Mi.	1.05	5.51	2.31
Storage Capacity				
Sediment	Ac. Ft.	56	104	53
Floodwater	Ac. Ft.	225	1,175	493
Total	Ac. Ft.	281	1,279	546
Surface Area				
Sediment Pool	Acres	9	18	6
Floodwater Pool	Acres	40	119	67
Volume of Fill	Cu. Yds.	86,282	190,348	119,567
Elevation Top of Dam	Feet	3,132.0	3,148.7	3,141.0
Maximum Height of Dam	Feet	27.1	36.2	34.0
Emergency Spillway				
Crest Elevation	Feet	3,127.0	3,142.7	3,134.5
Bottom Width	Feet	130	325	180
Type	--	Veg.	Veg.	Veg.
Percent Chance of Use	--	1	1	1
Average Curve No. Cond. II	--	72	75	74
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	2.0	8.0	3.25
Storm Rainfall (6 hr.)	Inches	10.0	10.8	10.0
Storm Runoff	Inches	6.49	7.63	6.75
Velocity of Flow (Vc) 1/	Ft./Sec.	4.6	5.4	5.4
Discharge Rate 1/	c.f.s.	390	1,600	900
Maximum W. S. Elevation 1/	Feet	3,128.6	3,145.1	3,136.9
Freeboard Hydrograph				
Storm Rainfall (6 hr.)	Inches	25.5	27.5	25.5
Storm Runoff	Inches	21.3	23.8	21.7
Velocity of Flow (Vc) 1/	Ft./Sec.	9.4	9.6	10.2
Discharge Rate 1/	c.f.s.	3,350	9,060	6,160
Maximum W. S. Elevation 1/	Feet	3,132.0	3,148.7	3,141.0
Principal Spillway Capacity 2/	c.f.s.	10.5	55.1	23.1
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	0.62	0.22	0.16
Above Crest of Prin. Splwy.	Inches	0.38	0.13	0.27
Total	Inches	1.00	0.35	0.43
Detention Volume	Inches	4.00	4.00	4.00
Spillway Storage	Inches	4.82	3.05	3.92
Class of Structure	--	c	c	c

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the discharge with the water surface elevation at the crest of the emergency spillway.

January 1965

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Lakin Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 4	TOTAL
Drainage Area	Sq. Mi.	3.33	12.20
Storage Capacity			
Sediment	Ac. Ft.	90	303
Floodwater	Ac. Ft.	711	2,604
Total	Ac. Ft.	801	2,907
Surface Area			
Sediment Pool	Acres	11	44
Floodwater Pool	Acres	82	308
Volume of Fill	Cu. Yds.	247,405	643,602
Elevation Top of Dam	Feet	3,118.8	xxxx
Maximum Height of Dam	Feet	40.8	xxxx
Emergency Spillway			
Crest Elevation	Feet	3,112.3	xxxx
Bottom Width	Feet	250	xxxx
Type	--	Veg.	xxxx
Percent Chance of Use	--	1	xxxx
Average Curve No. Cond. II	--	71	xxxx
Emergency Spillway Hydrograph			
Time of Concentration	Hrs.	4.0	xxxx
Storm Rainfall (6 hr.)	Inches	10.0	xxxx
Storm Runoff	Inches	6.36	xxxx
Velocity of Flow (Vc) 1/	Ft./Sec.	5.1	xxxx
Discharge Rate 1/	c.f.s.	1,040	xxxx
Maximum W. S. Elevation 1/	Feet	3,114.5	xxxx
Freeboard Hydrograph			
Storm Rainfall (6 hr.)	Inches	25.5	xxxx
Storm Runoff	Inches	21.2	xxxx
Velocity of Flow (Vc) 1/	Ft./Sec.	10.2	xxxx
Discharge Rate 1/	c.f.s.	8,250	xxxx
Maximum W. S. Elevation 1/	Feet	3,118.8	xxxx
Principal Spillway Capacity 2/	c.f.s.	33.3	xxxx
Capacity Equivalents			
Sediment Volume			
Below Crest of Prin. Splwy.	Inches	0.25	xxxx
Above Crest of Prin. Splwy.	Inches	0.26	xxxx
Total	Inches	0.51	xxxx
Detention Volume	Inches	4.00	xxxx
Spillway Storage	Inches	3.95	xxxx
Class of Structure	--	c	xxxx

1/ Maximum during passage of hydrograph

2/ These are average capacities based on 0.8 times the discharge with the water surface elevation at the crest of the emergency spillway.

January 1965

TABLE 3A - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Lakin Watershed, Kansas

Site No.	Drainage Area (Acres)	Drop (Feet)	Earth Fill (Cu. Yds.)	Concrete (Cu. Yds.)	Type Structure
1A	6,270 1/	8	600	62	Concrete Drop
2A	2,370 2/	6	400	44	" "

1/ 5,658 acres controlled by structures having release rate of 10 c.s.m.

2/ 2,134 acres controlled by structure having release rate of 10 c.s.m.

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TABLE 3B-STRUCTURE DATA

CHANNELS

Lakin Watershed, Kansas

Channel Designation	Sta. Numbering for Reach		Uncontrolled Drainage	Planned Channel Capacity	Average Bottom Width	Average Side Slope	Average Depth	Average Grade	Average Velocity in Channel	Volume of Excavation
	Sta. (100 ft.)	Sta. (100 ft.)	(sq.mi.)	(c.f.s.)	(ft.)		(ft.)	(pct.)	(ft./sec.)	(1000 c.y.)
Floodway #1										
Reach 1	0+00	17+00	0.09	98 1/	10	4:1	1.6	0.85	3.73	2.50
Reach 2	17+00	33+50	0.16	152 1/	14	4:1	1.8	0.85	3.99	4.18
Floodway #2										
Reach 1	0+00	18+00	0.13	195 2/	12	4:1	2.4	0.54	3.81	5.50
Reach 2	18+00	37+00	0.26	262 2/	16	4:1	2.5	0.54	4.03	6.99
Floodway #3										
Reach 1	0+00	12+80	0.03	65 3/	10	3:1	1.4	0.83	3.49	2.08
Reach 2	12+80	15+40	0.03	65 3/	10	3:1	1.4	0.77	3.32	0.20
Floodway #4										
Reach 1	0+00	14+50	0.13	72	8	3:1	1.9	0.4	2.79	3.08
Reach 2	14+50	26+00	0.28	103	8	3:1	3.0	0.13	2.03	1.06
Reach 3	26+00	35+64	0.37	108	8	3:1	3.2	0.13	2.10	3.09
Reach 4	35+64	40+49	0.37	108	4/	4/	4/	0.10	4/	4.00

1/ Includes 13.1 c.f.s. released from Structure #1
2/ Includes 68.9 c.f.s. released from Structure #2
3/ Includes 28.9 c.f.s. released from Structure #3
4/ This reach is a 60" diameter CMP

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TABLE 4 - ANNUAL COSTS

Lakin Watershed, Kansas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation, Maintenance, and Replacement Costs 2/	Total
Structural Measures	19,300	3,000	22,300

1/ 1964 prices amortized at 3 1/8 percent interest for a period of 100 years

2/ Long term projected prices

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Lakin Watershed, Kansas

(Dollars)[1/]

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop	10,700	300	10,400
Other Agricultural	6,300		6,300
Non-Agricultural			
Road and Bridge	300		300
Urban	19,800		19,800
Subtotal	37,100	300	36,800
Erosion			
Flood Plain Scour	1,600	100	1,500
Flood Plain Sediment	4,200	200	4,000
Indirect	4,700	100	4,600
Total	47,600	700	46,900
From Outside the Watershed	2,700	300	2,400
GRAND TOTAL	50,300	1,000	49,300

1/ Price base - long term projected prices

January 1965

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Lakin Watershed, Kansas

(Dollars)

Evaluation Unit	Average Annual Benefits 1/			Average Annual Costs 2/	Benefit Cost Ratio
	Flood Prevention				
	Damage Reduction	Secondary	Total		
Structural Measures	49,300	4,000	53,300	22,300	2.39:1

1/ Price base - long term projected
2/ Costs from table 4

January 1965

INVESTIGATIONS AND ANALYSIS

COOPERATION IN PLANNING

General

Some of the engineering phases of watershed planning were accomplished with funds provided by the State of Kansas. These funds were utilized through an engineering contract between the Soil Conservation Service and George M. McKee, Jr., Consulting Engineers, Colby, Kansas. All other technical services were provided by the Soil Conservation Service.

ENGINEERING

Surveys

All surveys were carried out using conventional engineering field methods. Elevations were referenced to mean sea level datum. Bench marks were established convenient to each proposed structure location. Eight cross sections and a bottom profile were surveyed on the channel below structures 1, 2, and 3. Topographic maps of the four proposed reservoirs were developed using a contour interval of four feet. Surface areas were measured from these maps to develop stage-storage curves and determine storage capacities. Centerline profiles of each dam were surveyed and used to compute embankment quantities.

Structure Design and Cost Estimates

The four floodwater retarding structures are planned with single stage principal spillways. These provided an economical design and kept the outflow at desirable levels. The crest of the inlet was planned at the elevation that provided the necessary sediment storage capacity in the reservoir. The crest of the emergency spillway was planned to provide in excess of the 100-year frequency detention storage above the principal spillway invert. This amount of detention storage would contain the largest storm of record. The freeboard hydrograph was routed through all structures with the maximum elevation equal to or less than the elevation of the top to the dam.

The concrete drop structures were designed to allow safe entrance of the 100-year, 6-hour discharge into the Amazon Ditch. Design discharge includes structure release plus discharge from the uncontrolled, contributing drainage area.

Floodway no. 4 is designed to carry the 100-year, 6-hour discharge from the area below the Amazon Ditch and west of Lakin. The roadway to be constructed on the east side of the floodway will provide the necessary depth through low areas.

All structure drainage area boundaries were stereoscopically delineated on aerial photographs. These areas were measured with a planimeter.

Structural data for each site is shown in table 3.

A cost estimate was calculated for each structure. Quantities of each item were based on surveyed data. Unit costs reflecting current bid prices for embankment, principal spillways, riprap, fencing, drain pipes, seeding, clearing, etc. were used to arrive at the total construction cost of each structure. Contingencies were calculated at 12 percent of the engineer's estimate. Installation services costs were calculated as a percent of construction costs.

Easements and rights-of-way costs were calculated for each site using unit values for cropland and pastureland agreed on by the sponsors.

Individual structure cost data is tabulated in table 2 and the total cost of all proposed structures is shown in table 1.

HYDROLOGY AND HYDRAULICS

The Amazon Irrigation Ditch provides a logical division of the flood plain. The flood plain below the ditch is flooded only after storm runoff from the area above exceeds the ditch capacity. The difference in frequency of flooding above and below the ditch was used as a basis for the flood plain division.

To obtain the relation of rainfall to runoff, the procedure as outlined in Chapter 3.10 National Engineering Handbook, Section 4, Hydrology, Supplement A, was followed. Hydrologic soil-cover numbers were developed for past and present watershed conditions. Future curve numbers will be the same as at present as land treatment is essentially complete. United States Weather Bureau Technical Paper Number 40 was referred to for rainfall-frequency relationships.

Detailed newspaper accounts of the 1949, 1951, and 1957 storms and resulting floods were examined. These accounts and additional personal interviews gave good precipitation-duration and antecedent moisture data for these three storms. Official records for Lakin and Deerfield supported this data.

Frequency of the three historical storms used in evaluation was determined by a comparison of actual runoff-duration log-log plots with synthetic runoff-duration plots for a range of frequencies using U. S. Weather Bureau TP-40. A frequency analysis based on discharge measurement was not possible. The broad alluvial fan flood plain and the topographic changes brought about by irrigation development rule out the use of cross sections for defining flood flows. Flood records kept since 1894 were used to compute the recurrence interval of damaging floods above and below the Amazon Ditch.

Floodwater retarding structure release rates were established considering downstream channel capacities and the capacity of the Amazon Ditch. Single stage release rates are planned in all structures. Maximum release rate is approximately 12 percent of the Amazon Ditch capacity. Individual structure release rates are shown in table 3.

Mass routings of the most severe storms of record were used to determine the floodwater detention storage volume. A check was made by the procedure in SCS Technical Release Number 10. Storms used in connection with this check were taken from Weather Bureau Technical Paper No. 40. The storage volume required to contain the most severe storm of record exceeds the 100-year frequency storage requirement.

Dimensions of the emergency spillways were determined by flood-routing the storms indicated in SCS Engineering Memorandum No. 27 by the method outlined in Lincoln E&WPU Memorandum No. 2. Emergency spillways will exceed minimum criteria as established by the State of Kansas.

The existing floodway capacity was determined by the slope-area method of water surface profile computation with field surveyed cross sections. This floodway has sufficient capacity to carry the 100-year frequency storm discharge with 2 feet of freeboard remaining on the south bank.

GEOLOGIC INVESTIGATIONS

Sedimentation In Reservoirs

Sediment rates and volumes were determined from sedimentation surveys made on existing reservoirs in the area. The range survey method was used to determine the sediment volume accumulated in each reservoir. Reservoirs studied were dry at the time surveys were made. Equipment used included survey instruments and hand augers.

Delta deposits were not found to be of consequence.

The significant sediment production factors of soil type, slope of the land, land use, and type of erosion were mapped on the drainage area above each surveyed reservoir. Sediment rates were computed for each reservoir. Variations in the sediment rates were equated to the difference in the sediment producing factors of the drainage area.

Sediment rating curves were developed from the above computations. These curves show sediment yield in acre feet per square mile per year versus drainage area size. The curves were plotted for a range of sediment producing factors.

Sediment producing factors of the drainage areas above floodwater retarding structures were mapped and compiled. Sediment yield to each reservoir was read from the sediment rating curves.

Flood Plain Erosion

The extent and severity of sheet scour, channel scour, and sediment resulting from floods on the flood plain were determined from field surveys. The eroded areas were mapped on aerial photographs. The degree of damage was based on the loss of productivity as compared with the unaffected parts of the field. Information derived from interviews with work unit personnel, soil scientists, and farmers aided in assembling land damage information.

Sheet, channel and sediment erosion was tabulated in acres with the percent of damage. Only eroded areas affected by upstream runoff were considered.

Future erosion in the next 50 years was estimated without the program. Future damage was based on soil type, present soil depth on the eroded areas, and the annual rate of erosion. The future damages were computed by:

> Present percent of damage divided by years of accelerated erosion times 50 years plus present percent of erosion is equal to percent of damage in 50 years (not to exceed 100 percent).

The recovery period in years was established from the amount of damage, the soil type, and the length and number of crop rotations required for potential recovery.

The potential recovery of soil productivity without floods depends primarily on the capability class of the soil and the present soil depth. Affected areas having soil with 60 inches or more in depth and in Class I and II are considered capable of full recovery. Other classes of land with less depth of soil were considered to recover partially as compared to original productiveness.

The percent of recovery at the end of the recovery period was determined by taking the present damage times percent of potential recovery times percent of area control.

Dam Sites

A geologic investigation was conducted at each proposed dam site. The work was accomplished by field observation, use of existing geologic maps, surveying instruments and hand augers. The report on each dam site included a centerline profile showing geologic conditions. The borrow area was shown on the topographic map and summarized on an attached sheet.

Significant geologic features that might influence the design or construction of a structure were investigated. A limited number of

test holes on the centerline determined the stability of the foundation. The amount of stripping and the depth of core trench were noted from the logs of the test holes.

The recommended location of the principal spillway was determined from the stability of the foundation, amount of excavation, length of conduit and the alignment of the pipe outlet to the stream channel. Quantities of materials to be excavated from the emergency spillway were estimated and their potential uses during construction were determined.

Soils were classified by the Unified Soil Classification system.

ECONOMIC INVESTIGATIONS

The average annual floodwater damages were determined using the procedures described in Chapter 3 of the Economics Guide. The following procedures were used to evaluate both on and off project benefits.

Basic data necessary for the determination of present damages was collected by personal contacts with farm operators, county and highway officials, and with local agricultural technicians.

Floodwater damage to crops reflect the net loss in income based on frequency of flooding. The area of cropland flooded and its frequency of flooding was determined. Average crop yields for the area adjusted to flood-free conditions were used in the evaluation. Agriculture land use and average yield was developed for both irrigated and dry land conditions.

The composite acre of crops on the flood plain and their flood-free yields are as follows:

Crop	Irrigated Cropland Percent Use	Flood-free Yield
Alfalfa	20	6 Ton
Sugar Beets	10	18 Ton
Grain Sorghum	30	90 Bu.
Wheat	25	50 Bu.
Forage Sorghum	15	18 Ton

Crop	Dryland Cropland Percent Use	Flood-free Yield
Wheat	34	21 Bu.
Fallow	33	-
Grain Sorghum	33	24 Bu.

A percent loss for each crop was developed considering depth of inundation and month of flooding. The percent damage was used to determine damage for the composite acre. The rates of damage thus developed were weighted by the percent of the year's excessive storms that occur in each month and averaged to give one damage value for each acre inundated. The damageable value was adjusted for frequency of flooding and multiplied by the acreage inundated.

Damage schedules were obtained from all of the landowners and operators of the flood plain. The specific storms covered were June 1949, May 1951, and June 1957. From rainfall records the frequency of these storms was determined. The damage schedules covered crop damages; land damages; other agricultural damages such as losses of livestock, machinery, and stored grain; removal of debris; and damage to private roads and fences.

Damages to grain storage facilities and the Amazon Irrigation Ditch were obtained from records of actual loss sustained. These losses were adjusted to reflect the frequency of flooding.

Road and bridge damages were based on information obtained from the county engineer's office as to repair and replacement costs. The damages to State Highway 25 were obtained from records of the State Highway Department, Division Engineer's Office, Garden City, Kansas. These damages were obtained on the three storms covered in the damage interviews and were adjusted for frequency of flooding.

Indirect damages were computed as 10 percent of the crop and other agricultural damage, 15 percent of road and bridge damage, 10 percent of urban residential damage, and 15 percent of commercial and public utilities. These damages were depreciation of property in the flooded areas, loss of time and additional expense of operators used in repair and cleanup which would normally be used in a productive operation, and additional distances driven by rural mail carriers, school busses, and farmers because of flooded crossings.

The estimate of damages to land through flood plain scour and sediment was made from data furnished by the geologist. This data included acres damaged, severity of damage, and period and degree of recovery due to the installed program. The economic evaluation was based on the net value of the composite acre. Changes in the net income due to scour and sediment damage were discounted at a 6 percent interest rate for 100 years.

Damage schedules were obtained from 60 percent of the residences flooded in the city of Lakin, from 95 percent of the commercial and retail businesses, and from all of the public utilities. Specific storms covered and their frequencies were the same as those used in collecting other agricultural damages. Damage schedules covered the

value of residence and contents; depth of flooding; damages to foundations, floors, walls, furnishings, garages, other buildings, automobiles, trucks, boats, grounds and improvements; evacuation and re-occupation expenses.

Information was also collected concerning homes which were constructed since the 1957 flood. This information was obtained by interviews with the home owners in which the value of the residence and contents, depth of previous flooding, and depth of flooding that would cause damage to the residence were determined. Based on frequency and depth of previous floods, benefits to these homes were computed.

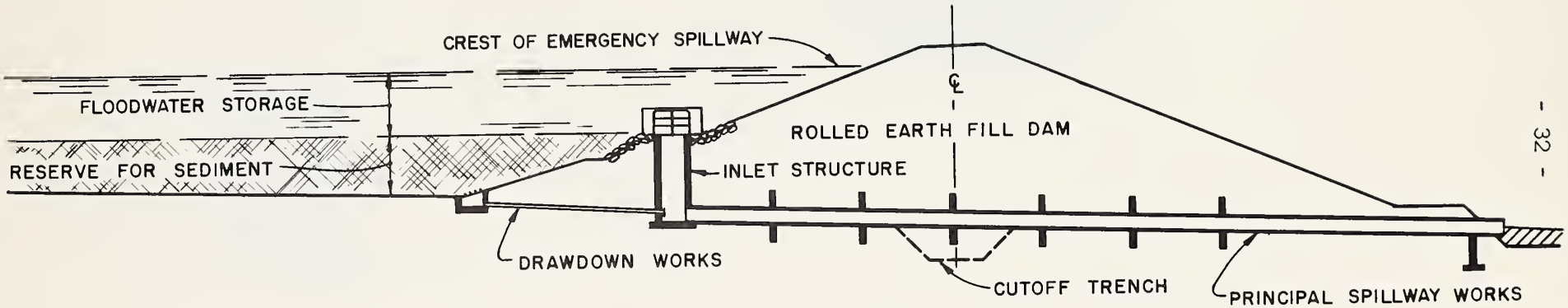
Future damages to urban development during the project period were computed based on the population trend from 1957 to present. This trend was expanded with a ceiling of 2,000 people within the city of Lakin at the end of the 100-year period. This increase in population amounts to 154 new homes over the project period or 1.5 new homes per year. Based on history of past flooding, the average annual damages to future urban development were computed. These were appropriately discounted to present worth.

Land easement costs were based on the value of cropland and pasture, as determined by the watershed directors. The values agreed on were: 60 dollars per acre for cropland and pasture for the floodwater detention sites. Land values of the sediment pool areas were based on 100 percent of its value, the structure and spillway areas on 75 percent, and the detention areas on 50 percent. The productive capacity retained under future conditions was thereby considered. An analysis showed that land values estimated were sufficient to offset income losses on land rights areas.

All monetary evaluations for benefits were based on long-term projected prices, using "Agricultural Price and Cost Projections," Agricultural Research Service, dated September 1957. Nineteen sixty-four construction costs, as experienced in Kansas P.L. 566 projects under construction, were used to estimate the contract costs of structural measures. Operation and maintenance costs were computed at 0.573 percent of construction cost for floodwater retarding structures. This factor also reflects long-term projected price levels. This method of computing O & M costs (outlined by the Lincoln Nebraska, Engineering and Watershed Planning Unit) is based on the principle that the relative probability of need for major type repairs decreases as the number of structures increases. Federal and local costs were amortized at 3 1/8 percent interest rate for a period of 100 years.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TYPICAL FLOODWATER RETARDING STRUCTURE



CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY

NOTES:

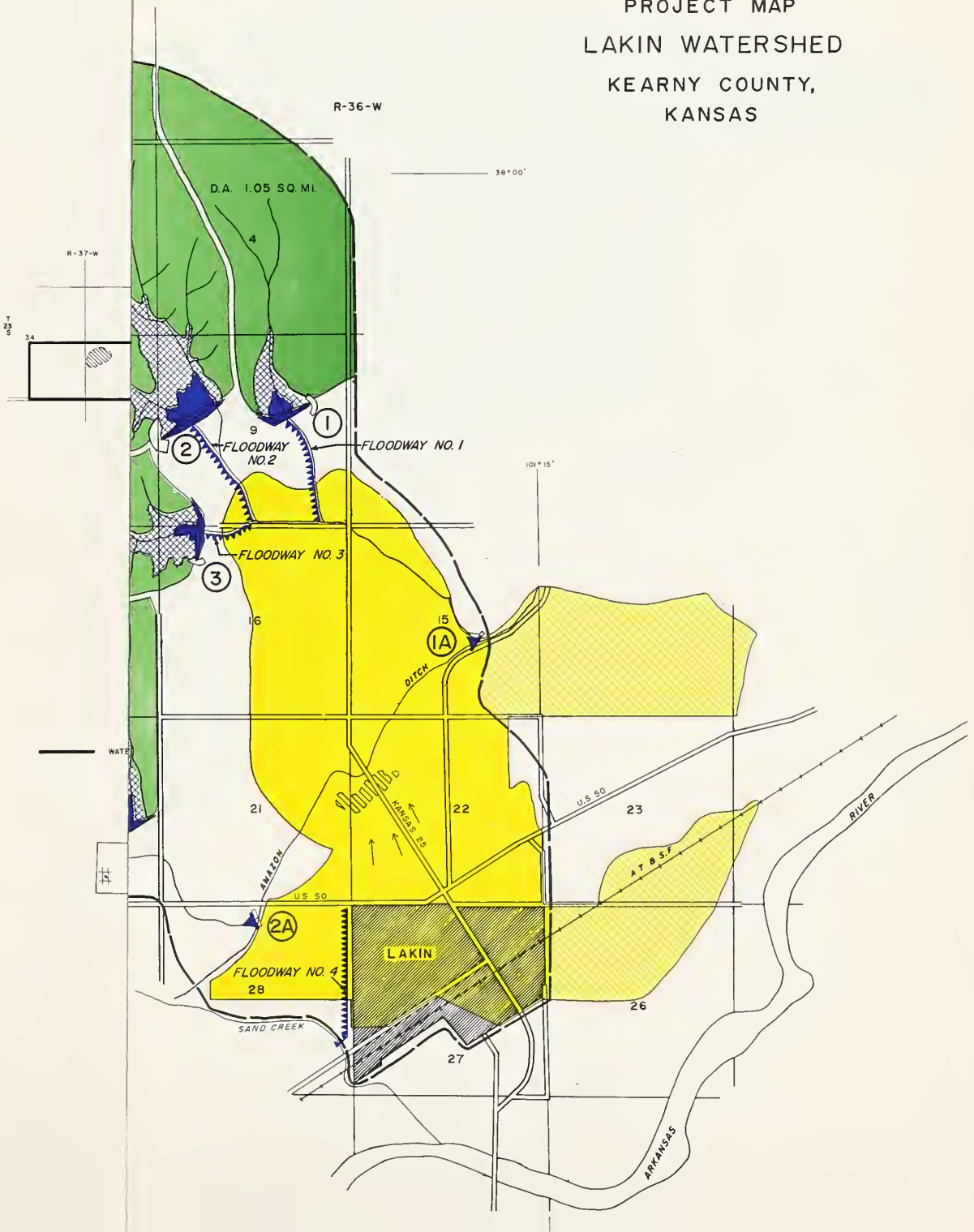
1. FOR INDIVIDUAL STRUCTURE DATA SEE TABLE 3.
3. EMBANKMENT AND FOUNDATION DESIGN FEATURES NOT SHOWN.

FIGURE 1

5,L-20,377
7-64

USDA SCS-LINCOLN NEBR 1964

PROJECT MAP
LAKIN WATERSHED
KEARNY COUNTY, KANSAS



U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LAKIN WATERSHED DISTRICT
NO. 49

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP
LAKIN WATERSHED
KEARNY COUNTY,
KANSAS

R-37-W

R-36-W

T 23 S

T 24 S

D.A. 5.51 SQ MI.

D.A. 1.05 SQ MI.

D.A. 2.31 SQ MI.

D.A. 3.33 SQ MI.

FLOODWAY NO. 1

FLOODWAY NO. 2

FLOODWAY NO. 3

FLOODWAY NO. 4

LEGEND

- RAILROADS
- ROADS
- WATERSHED BOUNDARY
- DEPRESSIONAL AREAS
- DRAINAGE AREA CONTROLLED BY PROPOSED STRUCTURE
- FLOOD AREA BENEFITED
- FLOOD AREA BENEFITED OFF PROJECT

PROJECT MEASURES

D.A. 2.31 SQ MI. — STRUCTURE DRAINAGE AREA
3 — STRUCTURE NUMBER
FLOODWATER RETARDING STRUCTURE
SPILLWAY
SEDIMENT POOL
FLOOD POOL
FLOODWAY
STABILIZATION STRUCTURE

KANSAS

N

SCALE 1 3/4 1/2 1/4 0 1 2 MILES

LAKIN

SAND CREEK

ARKANSAS RIVER

U.S. 50

A.T.&S.F.

KANSAS 23

AMBROSIA

D, R-20,651